Note regarding Document 3.1:

Facilities covered under old safety basis documents can continue to utilize the Safety Question Review (SQR) form (Appendix E) in the April 1, 2001 version of Document 3.1. The transition period shall extend until December 2008.

As new safety basis documents are instituted, the Change Control Form for Safety Basis Documents (Appendix I) in the March 4, 2004 version of Document 3.1 shall be utilized.

UCRL-MA-133867

ES&H manual

Environment, Safety, and Health

Volume I

Part 3: Safety Analysis and Work Plans and Procedures

3.1
Safety Analysis Program

(Formerly H&SM S6.06)

Recommended for approval by the ES&H Working Group

Approved by: Robert W. Kuckuck
Deputy Director for Operations

New document or new requirements

Approval date: September 1, 2000
Editorial Update: April 1, 2001

This work performed under the auspices of the U.S. Department of Energy by University of California Lawrence Livermore National Laboratory under Contract W-7405-ENG-48.

3.1

Safety Analysis Program*

Contents

---

* **Minor revision**

Appendices

Tables

Figures

.

3.1

Safety Analysis Program

1.0 Introduction

1.1 Purpose and Scope

Lawrence Livermore National Laboratory's (LLNL) Integrated Safety Management (ISM) system requires the assessment of hazards before conducting work. The safety analysis process is a formalization of elements of this assessment and is applicable to both Nuclear and non-Nuclear LLNL facilities. This document provides LLNL guidance and requirements for performing safety analysis of LLNL facilities and operations and for developing the facility administrative and engineered controls necessary to achieve an acceptable level of operating (residual) risk.

As the hazards and risks associated with a facility increase, the formality of the analysis, its documentation, and the level of effort to produce them all increase. The safety analysis process outlined here indicates how the level of formality is related to the hazards level through the "graded approach." Program and support organization involvement and management responsibilities are discussed. The requirements in this document are applicable to all LLNL facilities and operations.

1.2 Safety Analysis Documentation

Facility management must ensure that the assumptions and the results of the safety analysis of an operation are documented in a consistent format so that the information is available during development of work practices and procedures, training of personnel, and review of the operation for possible improvements in safety. This information is also needed when changes to operations are proposed.

The appendices to this document provide guidance for the format of the documentation for non-Nuclear facilities. Volume V of the *ES&H Manual*, DOE O 5480.23, and *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports* (DOE-STD-3009-94) provide requirements and guidance for content and preparation of Nuclear facility documentation.

The safety analysis documents discussed in this document and its references include the following:

- Facility Screening Report (SCR).
- Hazard Analysis Report (HAR).

- Safety Analysis Report (SAR), Safety Assessment Document (SAD).
- Unreviewed Safety Question (USQ), Unreviewed Safety Issue Report (USI) and Safety Question Review (SQR).

These documents, together with applicable Technical Safety Requirements, Operational Safety Requirements, Environmental Impact Statement and Environmental Impact Report, and the National Emission Standards of Hazardous Air Pollution Reports, when approved by the appropriate authorities, constitute an agreement between DOE and LLNL that limits the activities in a facility to those described.

1.3 Implementation

The revisions to this document shall be implemented as follows:

Process for Discovery of beyond SBE	Immediately upon approval by the DDO
Inventory reconciliation/management	90 days *
Systems, structures, components	180 days *

* From date of issue on the LLNL *ES&H Manual* Web Page.

2.0 Safety Analysis Process

2.1 The Graded Approach to Safety Analysis

The effort expended to perform and maintain the safety analysis and its documentation should be commensurate with the risks posed by the operation. For example, a typical office building requires only an inspection for unusual hazards and a short SCR recording the results. In contrast, the Plutonium Facility requires a rigorous safety analysis effort involving many program and support personnel and the production and DOE approval of a SAR.

The graded approach determines the type of analysis (hazard screening analysis, accident analysis, risk analysis), the type of documentation (Facility Screening Report, Hazard Analysis Report, Safety Analysis Report), and analysis technique (parking lot release, event tree analysis, quantitative risk analysis, etc.). Hazards Control document, SARA 00-26, "Facility Hazard Classification Methodology" August 28, 2000 is an internal Hazards Control document, that provides an acceptable methodology to use for analysis. The analysis process and its documentation are displayed in Figure 1 (a-d), *Flow Diagram for the Safety Analysis Process*.

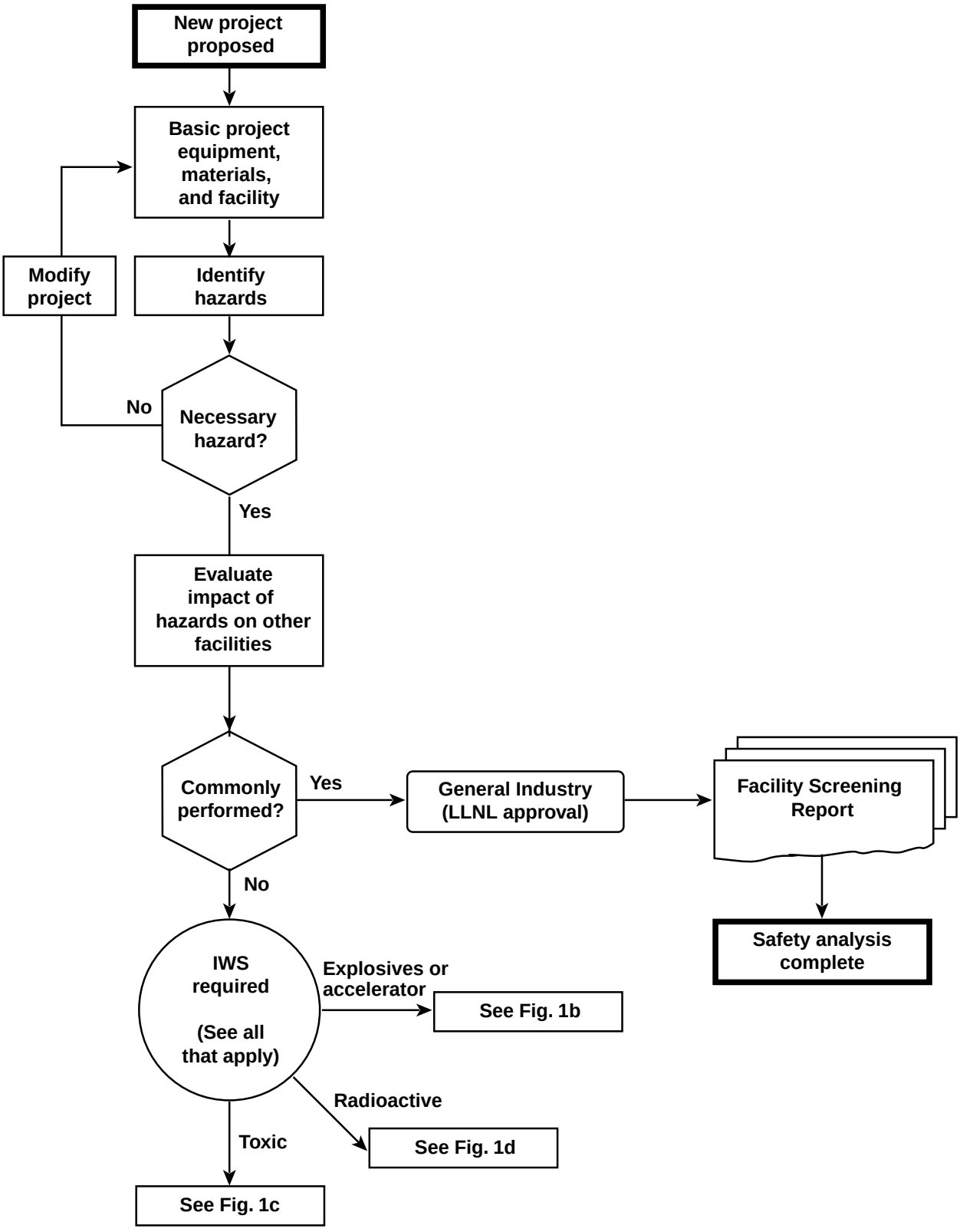


Figure 1.a. Flow diagram for the safety analysis process—integration into new project. (See terms and definitions, Appendix A).

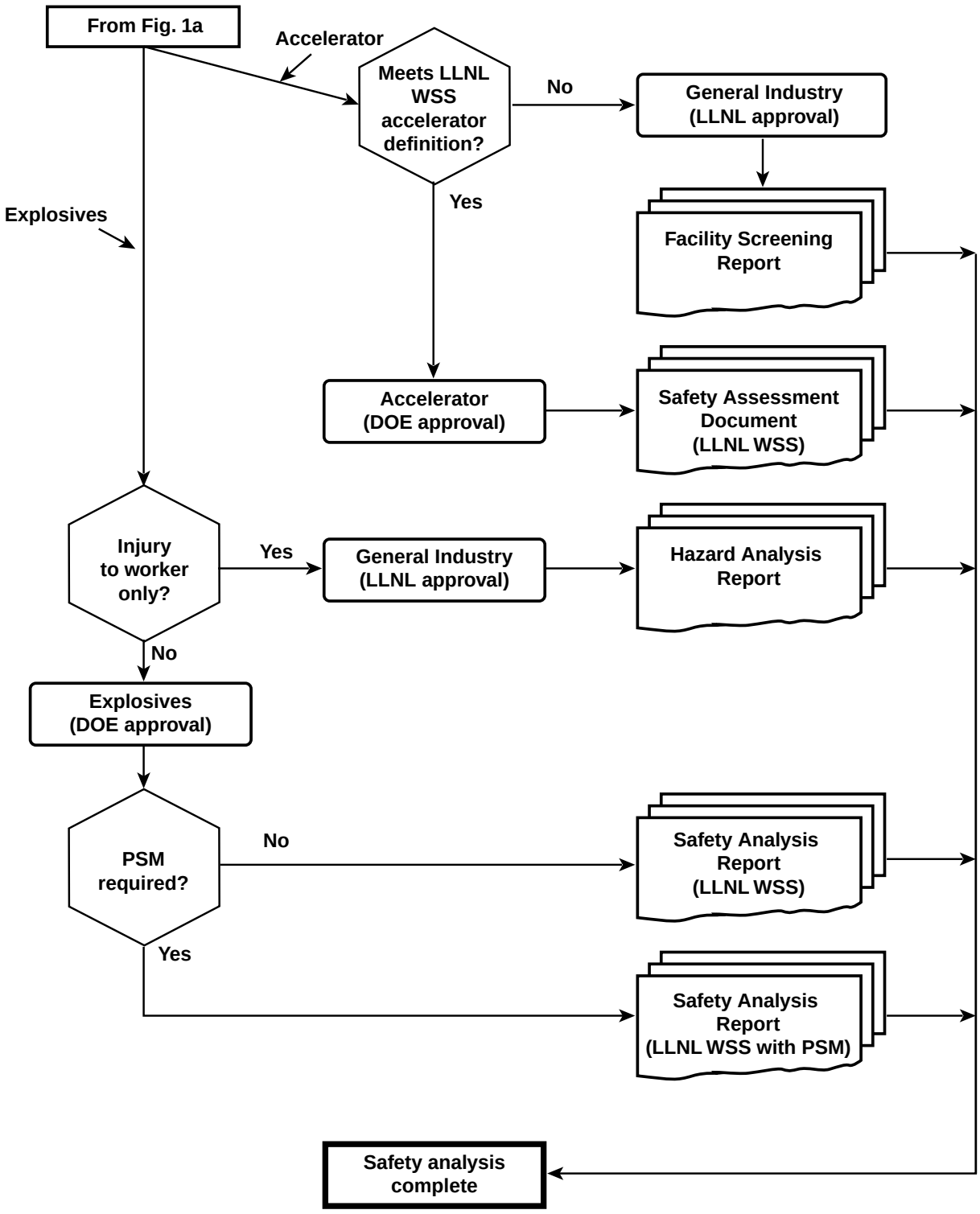


Figure 1.b. Flow diagram for the safety analysis process—Explosives and Accelerator hazards. (See terms and definitions, Appendix A).

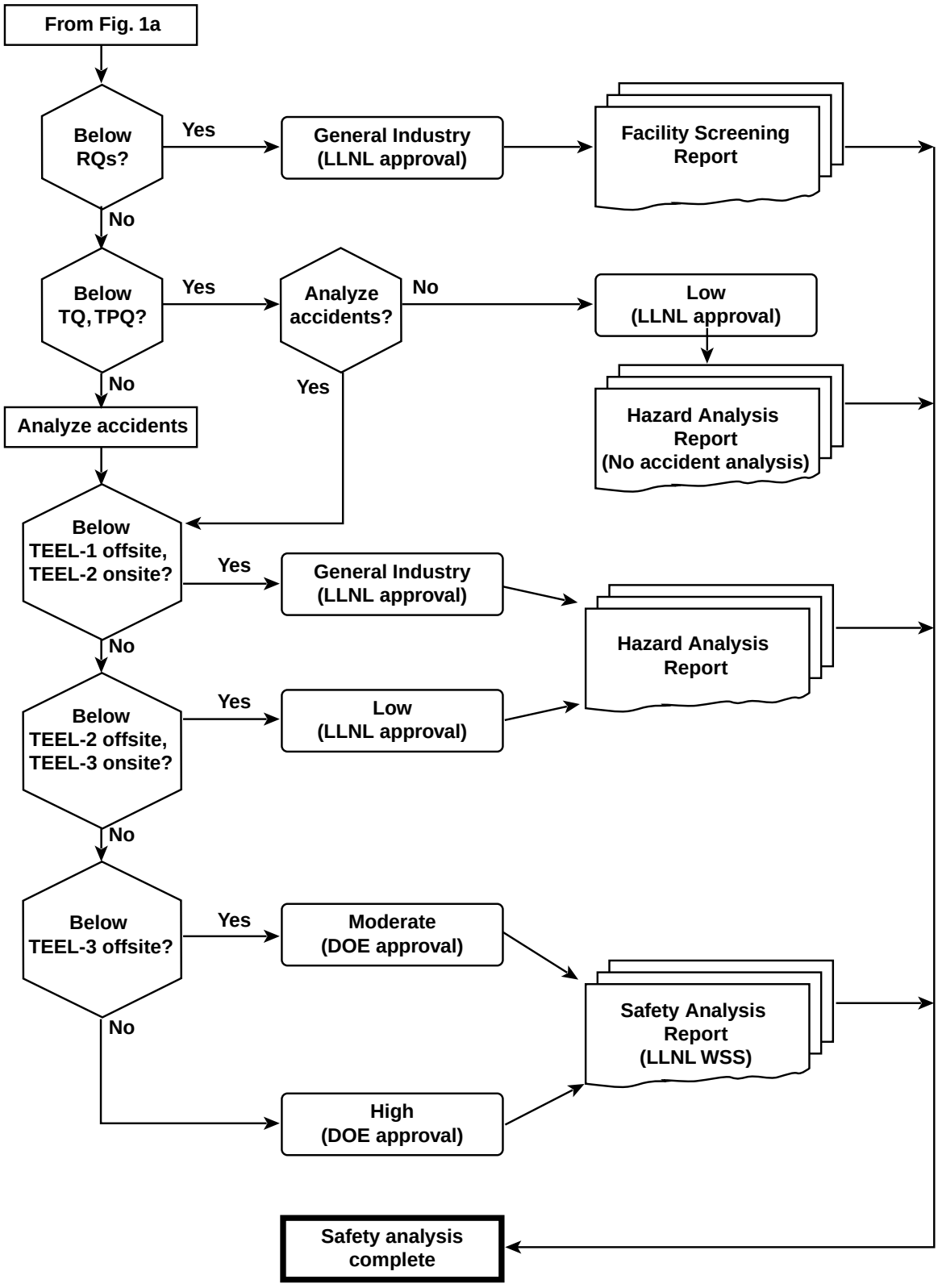


Figure 1.c. Flow diagram for the safety analysis process—toxic materials hazards. (See terms and definitions, Appendix A).

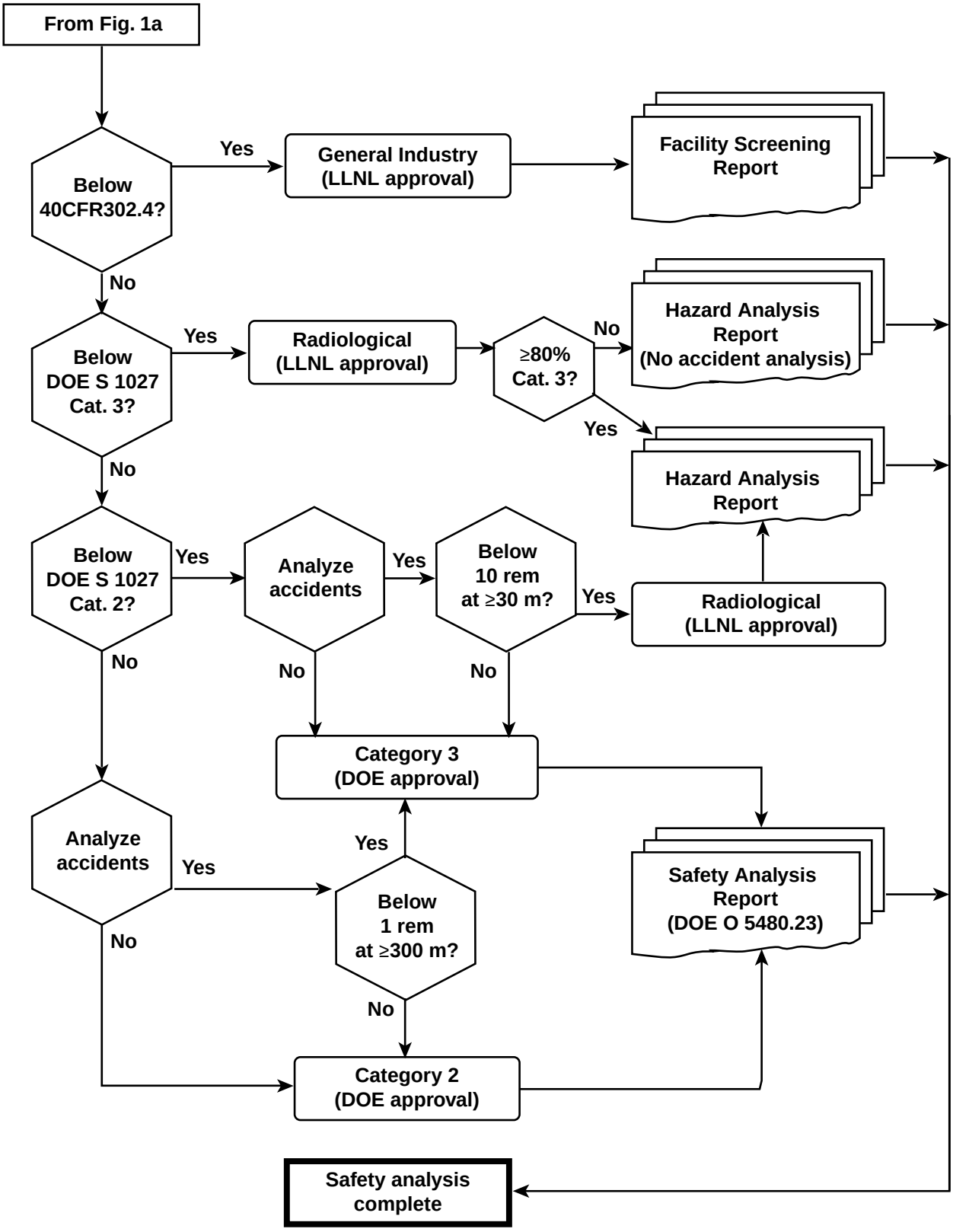


Figure 1.d. Flow diagram for the safety analysis process—radioactive materials hazards. (See terms and definitions, Appendix A).

Sections 2.2 through 2.7 of this document provide a brief description of the development and documentation of a safety analysis, indicating when decision points for applying the graded approach are reached and what level of effort and quantification is enough.

2.1.1 Hazard Type

The Laboratory identifies two categories of hazards associated with its operations: hazards that are associated with "activities commonly performed by the public," and all other hazards. (For the purposes of this document, hazards associated with activities commonly performed by the public are also referred to as "routine hazards.")

As a result of applying the graded approach, the safety analysis process established by the LLNL Work Smart Standards Set does not apply to activities commonly performed by the public, even though the consequences of accidents involving such hazards range from negligible to high for the individuals performing the work. The required mitigation and control of these hazards are achieved through the application of procedures and requirements discussed in the *ES&H Manual*, including requirements for equipment safety features and worker knowledge and training.

The application of this graded approach results in a significant reduction in the level of paperwork required for facilities containing only hazards associated with activities commonly performed by the public (i.e., routine hazards).

2.1.2 Probability

The probability of occurrence of an unexpected release of hazardous energy or material (an accident) determines its *credibility*. For the purposes of safety analysis, the probability is described as:

Less than credible — Events are expected not to occur during the life cycle of the facility, e.g., beyond-evaluation-basis accidents.

or

Credible and

- Extremely Unlikely — Events will probably not occur during the life cycle of the facility, e.g., evaluation-basis accidents.
- Unlikely — Events may occur once during the life cycle of the facility, e.g., natural phenomena, trained worker error.

- Likely — Events may occur several times during the life cycle of the facility, e.g., general worker error.
- Very Likely — Events may often occur, e.g., back strains, abrasions.

The safety analysis process must consider credible accidents. In most cases, less-than-credible events do not require analysis, so credibility provides a practical cut-off to the kinds of accidents that need to be considered and to the required level of effort and documentation of the analysis and implemented controls. Nuclear facility safety basis documents must discuss less-than-credible accidents, i.e., beyond-evaluation-basis accidents, in enough detail to develop a clear picture of potential consequences.

For most non-Nuclear facilities, qualitative determinations of credibility are all that is necessary. For Nuclear facilities, quantitative determinations may be required.

2.1.3 Consequence

The potential consequences of unexpected releases of hazardous energy or material are judged to fall into one of the following categories:

- Negligible — Events that result in no harm (no noticeable injury, illness, contamination, or damage) to people, the environment, or property.
- Low — Events that may result in minor injuries, illness, or environmental impact onsite, but no harm offsite.
- Moderate — Events that may result in severe injury or illness, major damage to facilities, and minor environmental impact onsite. There may also be minor injury, illness, and environmental impact offsite.
- High — Events may result in death, severe environmental impact, and destruction of buildings.

Table 1 lists the facility classifications (in descending order of unmitigated consequences for radioactive and toxic materials hazards) and the safety analysis documentation required for each classification. Classification is also the basis for determining the approval authority. Classification, then, has a direct impact on the level of effort required for completion of the facility safety basis.

The Laboratory has adopted facility-inventory-based hazard classification thresholds. These thresholds (see Sections 2.6 & 2.7) are used in direct comparison with the facility inventory to determine a hazard classification without extensive accident analysis, i.e., development of accident scenarios, analysis of resulting exposures of various populations, and comparison of those exposures to LLNL-adopted thresholds (see Sections 2.6.3 & 2.7.2).

2.1.4 Level of Risk

Risk is a function of probability and consequence. A 16-cell risk matrix (Appendix H) may be constructed to show the qualitative relationship among the four hazard levels (consequences), the four credible probability levels, and risk of an accident. The 16 cells may be grouped into four categories of residual risk: negligible, low, medium, and high. The first two categories of risk are acceptable for LLNL operations. High risk operations are unacceptable. Medium risk operations are acceptable only with DDO concurrence.

Table 1. Hazard classifications and associated safety analysis documentation[†]

Hazard types			
Radioactive materials	**Toxic materials[c]**	**Explosives**	**Accelerators**
Nuclear Hazard Category[a] 1 (DOE 5480.23 SAR)[b] **Nuclear Hazard Category 2 (DOE 5480.23 SAR)[b]** **Nuclear Hazard Category 3 (DOE 5480.23 SAR)[b]** **Radiological (HAR or SCR)[e]**	**High Hazard (SAR)[d]** **Moderate Hazard (SAR)[d]** **Low Hazard (HAR or SCR)[d]**	**Explosives (SAR)[d]**	**Accelerator (SAD)[d]**
General Industry (HAR or SCR)			

[a] LLNL does not have a Nuclear Hazard Category 1 facility.

[b] Preparation guidance for DOE 5480.23 SARs is provided in DOE-STD-3009.

[c] Evaluation guidelines for High-, Moderate-, and Low-hazard classifications are given in Tables 5 and 6.

[d] See format guidance provided in Appendix D of this document

[e] Format guidance for a SCR and a HAR can be found in Appendices A and B, respectively, of this document.

For facilities in the lower classifications, the combination of the classification and normal accident probabilities such as those related to human error rates cannot be more than low risk. For that reason, risk analysis is not required for General Industry, Radiological, and Low-hazard facilities.

[†] The safety analysis documentation requirements shown in this table range from the most complex (i.e., DOE 5480.23 SAR) through the non-Nuclear SAR, the HAR, and the SCR. When a facility has multiple hazard types, the safety analysis requirements for each hazard must be satisfied. The documentation reporting the analysis must include the necessary information. For example, a Category 3/Low hazard facility requires a DOE 5480.23 SAR that includes justification for both classifications and controls for both types of hazards.

For the higher hazard classifications, risk may be an issue. The task of risk analysis is incorporation of estimated failure probabilities (failure rate of components, human error rate) of existing controls and analysis of the effect of failure on the probability and consequences of accidents. Through this process, hazardous operations may be found to be low or negligible residual risk. On the other hand, less hazardous operations (i.e., operations with potential consequences that are relatively low) may be found to have such high accident rates that they are unacceptable without implementation of further controls.

Risk analysis also guides the selection of controls for reduction of the risk of unexpected events. For instance, the presence of passive barriers (e.g., walls, containers that prevent the release of materials or reduce the amount of material at risk of release) reduces risk. However, Nuclear, Accelerator, Explosive, Moderate and High-hazard research facilities are generally not low or negligible risk if hazard control relies entirely on such barriers. Additional preventive and mitigative controls may be applied administratively (worker training, safety device monitoring and maintenance, inventory limits, operating procedures, etc.) or through engineered active safety devices (e.g., automatic shut-off valves and fire dampers) to reduce the risk to an acceptable residual level.

2.2 Hazard Identification

To begin the safety analysis effort, the safety analyst assisting facility management performs a facility hazard screening. This screening consists of

- Consulting the facility management chain and appropriate program and support personnel to obtain an understanding of all known hazards
- Consulting the cognizant ES&H Team leader to confirm the hazards list
- Reviewing the following:
  - — The ChemTrack inventory for highly hazardous chemicals (as defined in 29 CFR 1910.119, 40 CFR 302.4, and 40 CFR 355).
  - — Radioactive inventory information.
  - — Facility or Operational Safety Plans and/or Integration Work Sheets (IWS) for hazards that might not be otherwise identified.
- Inspecting the facility for all hazards, including hazardous materials that are not typically included in the ChemTrack listing[‡] and hazards that are associated with activities commonly performed by the public. (Section 2.1.1).

[‡] **Hazardous materials not found in a ChemTrack listing include bulk materials, shipments from other DOE labs, intermediate or end product materials, and hazardous waste.**

The analyst may use the potential hazardous energy sources in Table 2 as a checklist for the identification process. The hazards identified in the facility screening may be common everyday hazards, hazards that only affect the workers in the facility, or hazards related specifically to DOE-contracted work that are of concern to persons outside the facility or to the environment. The analysis of the information collected in the facility screening allows identification of hazards and sorts them into several general groups: those associated with activities commonly performed by the public (Section 2.3), accelerators (Section 2.4), explosives (Section 2.5), radioactive materials (Section 2.6), and hazardous materials (Section 2.7). This screening analysis shall be formalized, approved, and recorded in a Facility Screening Report (See Appendix B for the form used for this report.) for General Industry Facilities. The hazard identification methods in this section shall, as a minimum, be used and incorporated, as appropriate, in to hazards analysis documents for all hazard ranked facilities.

Table 2. Hazardous energy sources.

Chemical energy	Electrical energy	Thermal energy
Corrosive materials	Capacitors	Steam
Flammable materials	Transformers	Fire
Toxic materials	Batteries	Solar
Reactive materials	Exposed conductors	Friction
Oxygen deficiency	Static electricity	Chemical reactions
Carcinogens		Spontaneous combustion
	Kinetic energy	Cryogenic materials
Radiant energy	Pulley, belts, gears	Ice, snow, wind, rain
Intense light	Shears, sharp edges	
Lasers	Pinch points	**Pressure energy**
Ultraviolet	Vehicles	Confined gases
X rays, γ rays	Mass in motion	Explosives
Infrared sources		Noise
Electron beams	**Potential energy**	
Magnetic fields	Falling	**Biological energy**
RF fields	Falling objects	Pathogens (virus, bacteria, etc.)
Nuclear criticality	Lifting	Allergens
High energy particles	Tripping, slipping	
	Earthquakes	

Consistent with the principles of Integrated Safety Management, any new project has to be reviewed for all potential hazards or safety impacts. Prior to the final approval of any activity or change in use or modification of an existing facility, facility management shall ensure there is no potential for this activity or change of use to affect the authorization basis or safety envelope of the facility or any other facility in the vicinity of the project/facility. Facility Management shall consult with the responsible ES&H Team or Teams for assessing these potential impacts.

If such a potential exists then the results of the analysis shall be provided as an amendment to the associated Integrated Work Sheet. When appropriate, any potential impacts shall be forwarded to LSO Space and Site Planning to be incorporated in Space and Site Planning documentation, e.g., Findings and Determinations.

2.3 Hazards Associated with Activities Commonly Performed by the Public

Most of the facilities at LLNL have only hazards associated with activities commonly performed by the public (i.e., routine hazards). Examples of such hazards are

- Gasoline used as fuel—found at commercial filling stations.
- Utility power—found in homes and general office buildings in commercially available office machines and food preparation appliances.
- Lifting, tripping, sharp hazards—found in everyday life.
- Machinery in motion, hot parts, etc.—found in machine shops.

However, it is sometimes necessary to consider hazards that appear to be associated with activities commonly performed by the public because

- Unusual quantities or concentrations of routine hazards are present.
- A hazardous material is used for non-routine purposes (e.g., gasoline used as a solvent).
- The hazard increases the potential for exposure to other hazards that are not routine.

For many LLNL facilities (including office buildings, general machine shops, and utility buildings), analysis of the facility hazard screening is sufficient to confirm that the only hazards present are those associated with activities commonly performed by the public, or the quantities of hazardous materials are below the thresholds established in this document. The hazard classification of the facility reported in the Facility Screening Report is General Industry and the LLNL-approved SCR becomes the safety basis document for the facility.

2.4 Accelerator Hazards

The facility screening establishes the hazard classification of an Accelerator facility since no further subdivision of the classification is required. Not all machines that accelerate charged particles require the Accelerator hazard classification or the associated safety analysis. For instance, machines that produce x-rays either for use or as an incidental byproduct are not included in this program. To be included as an accelerator, the machine must be capable of producing an external beam of accelerated particles with energies in excess of 10 MeV and also capable of creating a radiological area potentially exposing the whole body of a receptor.

Any device that meets these specifications is an accelerator subject to controls in the LLNL WSS that are drawn from DOE O 420.2. A safety analysis is required for any Accelerator facility. It is recorded in a Safety Assessment Document if only Accelerator hazards are identified. This document is a little different from SARs in that its purpose is to describe the safety features and procedures that prevent individuals from becoming exposed to the radiation, either primary or induced. (The SAD follows the form and should contain the elements outlined in the SAR form in Appendix D.) When a SAR is required for other hazards, the results of the accelerator safety analysis may be recorded in that document.

In addition, an Accelerator Safety Envelope, i.e., the physical and administrative bounding conditions for safe accelerator operations, must be documented.

DOE must approve the SAD (or SAR) and the Accelerator Safety Envelope and must conduct an Accelerator Readiness Review prior to start up or restart.

2.5 Explosives Hazards

The identification of an explosive inventory in a facility in excess of 10 mg of non-primary or 1 mg of primary explosive determines an initial classification of Explosives. The final classification as GI is documented in an SCR. The SRC or a hazards screening can identify that accident analysis be used to determine if the quantity of explosives is small enough that the effects of any *credible* accident (See Section 2.1.2.) would be limited to the worker. If the effects are limited in this way, then a final classification of General Industry is appropriate and the analysis and classification are documented in an LLNL-approved Hazard Analysis Report. (See Appendix C for guidance on the format of the HAR for a non-Nuclear facility.) However, if either the screening or the accident analysis determines that the facility must have an Explosives hazard classification, then the safety analysis must also include a risk assessment (Section 2.1.4) of the activity and be reported in a DOE-approved SAR, which becomes the safety basis of the activity. The application of procedures and requirements of the *DOE Explosives Safety Manual*, DOE M 440.1-1 creates the required mitigation and control of the identified worker safety hazards.

If explosives are manufactured, the requirements of Process Safety Management (PSM), described in 29 CFR 1910.119 must be met. Manufacture includes "mixing, blending, extruding, synthesizing, assembling, disassembling and other activities involved in the making of a chemical compound, mixture or device which is intended to explode" in "any quantity." However, OSHA considers some activities (e.g., scale-up, research chemical formulations, and assembly of engineering R&D models) outside the scope of the explosives manufacturing process if conducted in a non-production research or test area or facility. (See the letter of interpretation issued by the Department of Labor [Section 5.2, JB Miles]).

DOE must approve the SAR for *Explosives* facilities.

2.6 Radioactive Materials Hazards

LLNL has adopted action thresholds, referenced in Table 3, for use in developing an initial classification based upon inventory alone. On the basis of this comparison, the safety analyst will assign an initial hazard classification ranging from General Industry to Category 2 Nuclear (Only DOE may make a final Category 1, 2 or 3 classification.) LLNL facility management approves facility hazard classification.

Table 3. Standards for radioactive materials inventory thresholds.

Classification Threshold	Table column	Rule/Standard
Radiological	**Reportable Quantity ("Final")**	**40 CFR 302.4, Appendix B**
Category 3 (Nuclear)	**Columns 3, 4**	**DOE S 1027, Attachment 1**
Category 2 (Nuclear)	**Columns 1, 2**	**DOE S 1027, Attachment 1**
Category 1 (Nuclear)	**none**	**none**

The classification on the basis of inventory screening alone is usually highly conservative (i.e., indicates a higher risk than actually exists) as it does not include judgments of materials at risk and the mitigating effects of barriers and is based on the maximum intended inventory.

2.6.1 General Industry

If the facility inventory does not exceed the Radiological threshold and no other non-routine hazards (such as radioactive materials stored in Type B containers) are present, then the comparison and a General Industry classification are reported in an LLNL-approved Facility Screening Report. (See Appendix B for the SCR form.) This screening report is the facility safety basis document.

The mitigation and control of the identified worker safety hazards are achieved through the application of procedures and requirements discussed in the *ES&H Manual*, including requirements for equipment safety features and worker knowledge and training.

2.6.2 Radiological

If the facility inventory is between the Radiological and Nuclear Category 3 thresholds, then a Radiological classification is reported in an LLNL-approved HAR, containing only the facility description, the hazard identification tables, and the results of the inventory comparison. (See Appendix B for guidance on the format of the HAR for a non-Nuclear facility.) This document must show clearly that the inventory is controlled so that it will not accidentally exceed the Nuclear hazard threshold. In addition, if the inventory is expected to near the Nuclear threshold at any time, the facility operations should be reviewed for any accident scenarios that might be particularly effective in dispersing the radioactive inventory. Identification and evaluation of such scenarios should be included in the HAR.

2.6.3 Nuclear (Category 2 & 3)

If the facility inventory is above a Nuclear Category 3 threshold, then the appropriate category is assigned as an initial classification. Often, this classification is clearly the final classification of the facility as well. However, the values in the tables are based on simplifying assumptions that may be too conservative for the facility being analyzed. If this is the case, then analysis should be used in accordance with DOE-STD-1027 to determine the final hazard classification.

A final hazard categorization analysis may be possible using factors such as the material at risk, the material's properties (e.g., release fractions and rates), and containment (passive engineered or natural barriers). (Refer to DOE-STD-1027). The result of this analysis may be a different final classification. DOE approves the classification of a Category 3 or 2 facility. A final classification of Nuclear requires a DOE-approved SAR compliant with the requirements of DOE O 5480.23 to assess the risk (Section 2.1.4) of operating the facility. The SAR describes not only the engineered and administrative controls and assesses their contribution to risk reduction but also the management programs used to assure that those controls are in use. Based on the analysis of risk, the function of some of these controls may be so critical to the safe operation of the facility that there must be special effort to ensure their function, or, conversely, suspension of operations if the controls cannot function. Specifications and maintenance requirements for these critical controls are detailed in Document 51.2, "Technical Safety Requirements," in the *ES&H Manual.* The SAR plus the TSR form major portions of the safety basis. (The DOE Safety Evaluation Report and any USQs are also included in the safety basis.) See DOE STD-3009-94 for guidance concerning the contents of the SAR.

The mitigation and control of the identified worker safety hazards are achieved through the application of procedures and requirements discussed in the *ES&H Manual*, including requirements for equipment safety features and worker knowledge and training.

DOE must approve the SAR for Category 2 & 3 Nuclear facilities.

2.7 Hazardous Materials Hazards

A Facility Screening Report records the need for further analysis when hazardous materials (e.g., toxic, corrosive, carcinogenic, infectious) are identified in a facility. In order to apply effort commensurate with the hazards, LLNL has adopted action thresholds for chemical hazards, referenced in Table 4 and Appendix I, for use in developing an initial classification based upon inventory alone. On the basis of this comparison, the safety analyst will assign a classification ranging from General Industry to Moderate. (A High-hazard designation requires comparison with the consequences discussed in Section 2.1.3.)

Table 4. Standards for hazardous chemicals inventory thresholds.

Classification Threshold	Table column	Rule/Standard
Low	**Reportable Quantity ("Final")**	**40 CFR 355, Appendix A**
Low	**Reportable Quantity ("Final")**	**40 CFR 302.4 Appendix A**
Moderate	**Threshold Quantity**	**29 CFR 1910.119, Appendix A**
Moderate	**Threshold Planning Quantity**	**40 CFR 355, Appendix A**

Classification on the basis of inventory screening is usually highly conservative (i.e., indicates a higher hazard than actually exists), as it does not include judgments of materials at risk and the mitigating effects of barriers and it is based on the maximum intended inventory.

2.7.1 General Industry

If all the chemicals in a facility's inventory meet any of the following criteria, the classification is General Industry:

- Are on the referenced lists but are less than the RQs or
- Are not on the referenced lists but satisfy one of the following conditions:
  - Less than 1 lb. of solids or liquids

- Less than 100 lb. of solids or liquids or 10 lb. of gasses, and NFPA Health Hazard ratings of 1 or 2 or TEEL-2 (Temporary Emergency Evaluation Limit, [Craig, 00]) > 100,
- In common use by office workers, the public, or others,
- Are judged by the safety analyst to have the potential for impact only on facility workers.

This is reported in an LLNL-approved Facility Screening Report. (See Appendix B for the SCR form.) This screening report is the facility safety basis document.

The mitigation and control of the identified worker safety hazards are achieved through the application of procedures and requirements discussed in the *ES&H Manual*, including requirements for equipment safety features and worker knowledge and training.

2.7.2 Low, Moderate, or High

In the event that some material quantities in the inventory exceed only their Low hazard thresholds but all materials either have LLNL-adopted thresholds or are innocuous, and no other non routine hazards are identified, then a Low classification may be reported in an LLNL-approved HAR (inventory comparison only). Since the values in the tables may be overly conservative for the facility being analyzed, accident analysis may be used to determine if the final hazard classification can be shown to be General Industry. The analysis and its conclusions are reported in an LLNL-approved HAR.

However, if the facility inventory quantities are above Moderate thresholds or other hazards associated with activities that are not commonly performed by the public are identified, then an accident analysis is required to establish a final classification. In accident analysis, the safety analyst uses factors—such as the material at risk, the material's properties (e.g., evaporation rates), containment (passive engineered or natural barriers), and airborne propagation under ambient atmospheric conditions—to determine the consequences of a *credible* (Section 2.1.2) release to LLNL workers and the public. The potential exposure that results from the dispersion is compared to exposure thresholds (Table 5) adopted by LLNL for use in determining hazard classification. Active barriers (e.g., ventilation, automatic shut-off valves) and administrative controls may not be considered in this analysis.

Use of the graded approach by limiting the development of scenarios can reduce the accident analysis effort. For instance, the analysis of a simple release external to any structure (an unmitigated release) is the most conservative and involves the least effort.

In the event that the final classification resulting from the accident analysis is General Industry or Low, the LLNL-approved HAR is the safety basis for the facility. A final classification of Moderate or High requires DOE approval as well as a SAR compliant with the requirements of the LLNL Work Smart Standards to assess the risk

Table 5. Standards for chemical exposure thresholds.

Rule/Standard	Table column	Classification Threshold
Temporary Emergency Exposure Limit	TEEL*-1	General Industry if on site (>100 m) Low if off site
Temporary Emergency Exposure Limit	TEEL–2	Low if on site (>100 m), Moderate if off site
Temporary Emergency Exposure Limit	TEEL-3	Moderate if on site (>100 m), High if off site
40 CFR 68, Appendix A	Toxic endpoint	Moderate if off site

* Temporary Emergency Exposure Limit—airborne exposure concentrations used as shown to determine hazard classification. The latest values are located at <http://tis.eh.doe.gov/web/chem_safety/teel.html>

(Section 2.1.4) of operating the facility. The SAR describes not only the engineered and administrative controls and assesses their contribution to risk reduction but also the management programs used to assure that those controls are in use. Based on the analysis of risk, some of these controls may be so critical to the safe operation of the facility that they require special effort to ensure their operation, or, conversely, suspension of operations if the controls cannot be operated. Specifications and maintenance requirements for these critical controls are detailed in a discussion of Operational Safety Requirements in the SAR. The SAR plus the OSRs form the facility safety basis.

Appendix D contains a table of contents to be used as a guide for developing the SAR for a non-Nuclear facility. It is useful to adhere to the Chapter divisions shown. The subdivisions are shown as an indication of what information should be considered for inclusion in the SAR and how it could be organized. It is appropriate to obtain agreement with the DOE concerning inclusion or exclusion of various topics prior to writing the SAR.

DOE must approve the SAR for Moderate and High hazard facilities.

2.8 Scheduling Safety Analysis

As soon as a new project or facility moves past the conceptual stage, the program manager should make preparations to develop the preliminary safety analysis documentation. As the design of the operation changes, so should the safety analysis. In this way, safety issues and their controls are developed as an integral part of the project design process.

The project team must estimate the inventory quantities and usage of toxic or radioactive materials for the new activity. A preliminary hazard classification may then be assigned, giving some bound to the level of effort required for achieving the final

safety analysis. Particular care must be taken when the inventory involves radioactive materials because the step to Nuclear facility status brings with it a significant increase in the cost of operations and documentation.

A preliminary safety analysis (i.e., a preliminary SCR, HAR, or SAR, as required) must be approved before significant hardware funds are committed or construction begins. Changes to the project, as-built configurations, and new information concerning the operation must be incorporated and the final safety analysis documents approved before operations begin.

The Hazards Control Department can provide safety analysts to support the facility management in conducting the facility screening, the hazard analysis, and the risk assessment, determining the hazard classification and residual risk, and preparing the SCR, HAR, or SAR.

Communication between facility workers and the team assigned to perform the safety analysis and prepare the report is a critical element of the analysis that avoids late discovery of risks and expensive safety retrofits. The input of facility workers is essential and can result in net savings for the project. The early involvement of the DOE facility representative in the process of safety analysis development is also important. The representative's attendance at team meetings and inclusion in the technical discussions can speed approval of the completed SAR because the possibility of new issues arising during the DOE review process is minimized.

2.8.1 Major Operation or Regulatory Changes

On occasion, a major change in direction, ownership, or impact of an existing operation is impending or new analysis and documentation requirements are imposed (e.g., promulgation of DOE O 5480.23), requiring safety basis changes too broad to be incorporated in the normal change management process. Under these conditions, a new SAR must be prepared and approved prior to implementing the changes.

2.9 Reviewing and Approving Safety Analysis Documents

2.9.1 Facility Screening Report

After the safety analyst completes the Facility Screening Report, it is sent to the ES&H Team for concurrence and facility AD or a designee for approval. An approved copy of the report is filed in Hazards Control's Safety Analysis Records Archive.

2.9.2 Hazard Analysis Report

The Hazards Control Department Technical Leader for Safety Analysis, the ES&H Team leader, and the facility manager review the HAR. The facility manager approves the report for General Industry facilities, and the facility AD or a designee approves the report for Low and Radiological hazard classification facilities. Approval of the report indicates acceptance of its conclusions and the level of risk for operation under the envelope of the safety analysis as documented in the HAR. If a HAR is prepared for a higher hazard-level facility, the same management authorities must review it as those approving the facility's SAR.

2.9.3 Safety Analysis Report

The Technical Leader for Safety Analysis, the ES&H Team leader, and the facility manager review the SAR or SAD. Subsequently, it is sent to the Deputy Director for Operations or the appropriate designee (see Section 3.2) for concurrence and then to the facility AD for approval. The facility AD submits the SAR to the DOE/Oakland Field Office for approval. Operations cannot begin until DOE issues a letter approving the SAR and operation of the facility. If the document submitted to DOE is a Preliminary Safety Analysis Report (PSAR), then the operation to be approved is the construction of the facility, while, if it is a Final SAR (FSAR) then the operation is the experimental or production activity for which the facility was designed.

DOE's approval is stated in a separate letter; not indicated on the signature page of the SAR.

The internal review and approval process is critical to the success of the Safety Analysis Program to assure consistency in format, technical approach, and incorporation of appropriate safety controls.

Some existing facilities are currently operating under a previously developed safety analysis document called "Basis for Interim Operations" (BIO). A BIO is a DOE approved safety basis document for those facilities until a SAR for the facility is completed. Small changes to the existing facilities or operations shall be made in accordance with Section 2.11 below.

2.10 Implementing the Required Controls Documented in the Safety Analysis

Safety analysis documents describe the hazards, and controls associated with facility operations. Controls for hazards associated with activities not commonly performed by the public included in the safety requirements for each facility are implemented in the FSP or OSPs for the facility. It is especially important that these plans also include the controls for maintaining the Technical Safety Requirements (Nuclear facilities),

Operational Safety Requirements (non-Nuclear), and required (all occupied facilities) life safety systems identified in the safety analysis, as they are critical to maintaining the approved risk of operations.

2.11 Maintaining Safety Analysis Documentation

As operations begin in a new facility or continue in an old one, new understandings of the operational requirements, additional equipment, and unexpected system interactions may all require operational changes. The approved safety analysis documentation must be maintained so that it continues to describe the operation. Therefore, a process for approving and incorporating changes is essential. This process is triggered if there is the potential for *significant* safety issues resulting from any of the following situations:

- A planned change in operations or inventory.
- A discovered deficiency in the existing safety analysis.
- A discovered discrepancy in the "as-built" facility.

It is noted that changes in Federal regulations, such as the DOE nuclear safety rules, or in Contract 48 requirements applicable to the facility will also initiate document change reviews. These changes, however, are expected to have less urgency than changes initiated by the discovery of deficiencies in a SAR or a planned change in operation.

It can be expected that there might be a flurry of change reviews in the early stages of programmatic work in a facility. Later, some change reviews will occur as the work objectives of the project are achieved and the work is redirected toward new goals.

For non-Nuclear facilities, safety analysis documents are to be updated at least every 5 years. If change reviews have been conducted during this 5-year interval, the revised HAR or SAR must include the new information. Proper maintenance of these documents through the change management process should render the 5-year update little more than an editorial effort.

Nuclear facilities are required to update their SARs annually, with review information incorporated in the SAR at its next annual update.

The mechanisms for managing the configuration of hazards and controls in safety basis documents are the Unreviewed Safety Question (USQ) for Nuclear facilities, the Unreviewed Safety Issue (USI) for accelerators, and the Safety Question Reviews (SQRs) for explosive, moderate level facilities. For non-nuclear facilities, the Integration Work Sheet, used as a prescreening, is an appropriate mechanism for review of changes to the safety basis.

The result of a management-of-change review is either a positive or a negative finding. A negative finding is a conclusion that the existing safety analysis adequately bounds the issue being reviewed. A positive finding is a conclusion that the safety analysis does not properly include the projected operation (for a planned change) or the existing operation (for a discovered deficiency in the analysis, discrepancy in the as-built facility, or new regulation). The review is guided by the questions such as those contained in the SQR form (Appendix E), USI form (Appendix F) or the USQ process (Document 51.3, "Unreviewed Safety Question Process," in the *ES&H Manual*).

Appendix G provides a process for the management of change (configuration management) including 1) a graded approach for configuration management of facility level hazards and controls; 2) management of hazardous material inventories within facility safety basis inventory thresholds; and 3) notification, evaluation, development and approval of operations with compensatory measures.

The facility manager can approve a negative finding report and the new or continued operation. Positive reports must be reviewed and approved by the management chain (including Institutional concurrence and DOE approval, where appropriate) for the existing safety analysis documentation. The approved change review document, accompanied by the necessary analysis, becomes part of the facility safety basis and must be incorporated in the appropriate authorizing document during the next update. Use of the change review process has the advantage that the review and approval process is restricted to a single issue instead of reopening the entire safety analysis for review.

3.0 Responsibilities

3.1 Lawrence Livermore National Laboratory

The DOE/Oakland Field Operations Office has delegated to LLNL the responsibility to develop and approve the safety analysis for facilities with General Industry, Radiological, and Low-hazard classifications. However, DOE/Oakland retains approval authority for those with Nuclear, Accelerator, Explosive, Moderate, and High hazard classifications. Note that at any time and for any LLNL facility, DOE may choose to rescind its delegation of approval authority. In addition, DOE always retains the right to demur with the conclusions of any safety analysis document prepared by LLNL.

3.2 Deputy Director for Operations

The Deputy Director for Operations (DDO) signs (or delegates authority to sign) SARs in concurrence with the facility AD responsible for the safety analysis. The DDO normally delegates authority for concurrence to the Hazards Control Department Head

for non-Nuclear facilities and to the Associate Deputy Director for Operations for Nuclear facilities. Concurrence for medium risk operations is not delegated.

3.3 Facility Associate Directors

The facility AD has the responsibility for assuring that operations in a facility are performed safely and for developing, implementing, and maintaining the safety analysis for each facility. The facility AD is specifically responsible for

- Developing and maintaining safety analysis documentation.
- Requesting support, if necessary, from the Hazards Control Department as early as possible so that department staffing and schedules can be properly adjusted.
- Funding the safety analysis effort.
- Managing the development of the safety analysis.
- Approving the safety analysis and accepting the findings concerning risk and the need for controls of hazards.
- Obtaining DOE approval for SARs and SADs.
- Transmitting copies of all completed safety analysis documents (e.g., HARs, SARs, DOE Safety Evaluation Reports (SERs), DOE approval letters, USQs, USIs, SQRs) to the Hazards Control Department Technical Leader for Safety Analysis for inclusion in the Safety Analysis Report Archive.

3.4 Program Associate Directors

Program management is responsible for

- Providing input concerning programmatic operations, inventories, equipment, facilities, and procedures for safety analysis documents.
- Ensuring that the information about the programmatic operation is correct and complete.
- Maintaining appropriate operating conditions for programmatic work.
- Reviewing the safety analysis documentation to ensure it accurately reflects the work hazards.

3.5 Hazards Control Department

The Hazards Control Department provides safety analysis advice and support, when requested, to Laboratory programs and facilities by

- Interpreting rules, Contract 48 requirements, and the LLNL *ES&H Manual* as they apply to specific operations at the Laboratory.
- Reviewing programmatic and facility documents for compliance with the safety rules, contract requirements, and work practices.
- Monitoring programmatic and facility activities to assure that approved procedures are followed.
- Supplying safety analysts to help in the development and maintenance of facility safety analysis documentation.

3.5.1 Hazards Control Department Head

The Hazards Control Department Head has the delegated authority to concur with and sign non-Nuclear SARs before the responsible AD approves them. In signing, the Department Head indicates agreement that the document

- Has a technically accurate safety analysis.
- Supports the conclusion that LLNL can approve the risk.
- Contains the detail required to conform to accepted practice and requirements.

3.5.2 The Hazards Control Technical Leader for Safety Analysis

- Maintains a database (LLNL Hazard Classification List) of the hazard classification and status of the safety basis for each facility at Livermore and at Site 300.
- Notifies facility managers when the reviews for their facilities are due. The review schedules are also provided to the ES&H Team leaders for use during budgeting discussions with management.
- Reviews safety analysis documentation for technical accuracy and consistency in format and content.
- Maintains copies of safety analysis documents for all LLNL facilities.

3.5.3 ES&H Team

The ES&H Team provides input for the safety analysis and reviews draft safety analysis documentation. The team also assures that all input to the safety analysis correctly describes the operations and controls and that the safety analysts have correctly incorporated this information in the analysis.

4.0 Work Standards

DOE Order 5480.21, "Unreviewed Safety Questions" (December 24, 1991).

DOE Order 5480.22 Chg. 2, "Technical Safety Requirements" (January 23, 1996).

DOE Order 5480.23, Rev. 1, "Nuclear Safety Analysis Reports" (March 10, 1994).

DOE Standard 1027-92, Rev. 1, "Hazard Classification and Accident Analysis Techniques For Compliance With DOE Order 5480.23, Nuclear Safety Analysis Reports," §2, §3, §4 and Attachment 1 (except for the requirement for Certificates of Compliance for Type B containers), (September 1997).

DOE M 440.1-1, *DOE Explosives Safety Manual* (including DOE Explosives Safety Committee approved changes through the 39th ESC meeting minutes of October 28–29, 1998).

DOE Order 440.1, "Worker Protection Management for DOE Federal and Contractor Employees" (March 27, 1998).

DOE Order 420.2, "Safety of Accelerator Facilities" (November 5, 1998), Contractor Requirements Document, §§a-d only.

DOE SAN MD 5481.1A, "Safety Analysis and Review System," §3—Scope, §4—Exclusions, Chapter 1 §2e (1), (2), (3), (4), (6), and (7), (September 20, 1989).

5.0 Resources for More Information

5.1 Contacts

- Directorate assurance manager.
- Environment, Safety, and Health (ES&H) Teams.
- Hazards Control Department, Safety Program Division.

5.2 Other Sources

DOE Standard 3009-94 Change 1, "Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports" (January 2000).

J. B. Miles, *Applicability of PSM standard to explosive and pyrotechnic manufacturing*, Directorate of Compliance Programs, Occupational Safety and Health Administration, Department of Labor, (2/4/98).

(http://www.osha-slc.gov/OshDoc/Interp_data/I19980204A.html)

DOE Standard 3011-94, "Guidance for Preparation of DOE 5480.22 (TSR) and DOE 5480.23 (SAR) Implementation Plans," (November, 1994)

Hazard Control Department SARA 00-26, "Facility Hazard Classification Methodology" August 28, 2000

Appendix A

Terms and Definitions

Accident analysis	The determination of the consequences (dose or exposure) of a release of materials and the comparison of these consequences with published thresholds for dose and exposure adopted by LLNL for use in facility classification.
Beyond-evaluation-basis accident	An accident that is expected not to occur during the lifetime of the facility.
CEDE	Committed Effective Dose Equivalent—a measure of the impact of the uptake of any radioactive material into the body over a 50-yr. period.
Consequence	The impact of an event on safety, health, the environment, or property.
Consequence thresholds	Published quantities, concentrations, and doses that are used to rank consequences and establish hazard classifications.
Credibility	The credibility of an accident is its probability of occurrence.
Credible consequence	The consequence of an event that must be considered in the evaluation of the facility.
General Industry	A General Industry hazard facility may house activities with hazards associated with activities commonly performed by the public and activities involving non-routine hazards but only negligible accident consequences. (Previously called Excluded).
High consequence	Deaths, severe environmental impact, destruction of buildings.
Inventory analysis	Comparison of quantities of hazardous materials with published thresholds adopted by LLNL for use in facility classification.
Low consequence	Minor injuries, illness, or environmental impact on site; no harm off the LLNL site.

Moderate consequence	Severe injury or illness, major damage to facilities, and minor environmental impact on site; minor injury, illness, and environmental impact off site.
Negligible consequence	No harm (no noticeable injury, illness, contamination, or damage) to people, the environment, or property.
Operating (residual) risk	The risk of operating a facility that remains when administrative controls and active and passive safety features have been developed and put into use.
Process Safety Management (PSM)	Additional safety documentation required for facilities whose hazardous materials inventories exceed the quantities listed in 29 CFR 1910.119, Appendix A.
RQ	Final Reportable Quantity—Chemical inventory threshold from 40 CFR 355, Appendix A and 40 CFR 302.4.
TPQ	Threshold Planning Quantity—Chemical inventory threshold from 40 CFR 355, Appendix A.
TQ	Threshold Quantity—Chemical inventory threshold from 29 CFR 1910.119.
Safety analysis	A systematic process to identify and analyze the hazards of an operation, the associated potential consequences and risk of accidents, and the adequacy of measures taken to eliminate, control, or mitigate the hazards, and to document this information.
Safety Evaluation Report	A document that reports the conclusions of a DOE/OAK analysis of a nuclear facility SAR. DOE/OAK approval of a nuclear facility operation is based on the SER and it becomes part of the safety basis for the facility.
Safety of operations	A term used in the USI form (Appendix E) to describe the impact of controls of hazardous inventories, physical limits of safety equipment, probabilities of failure and other elements. Changes in operations may cause administrative limits to approach more closely classification thresholds, physical limits, or increase probabilities so that safety is judged to be reduced.

TEEL	Temporary Emergency Exposure Limit—Airborne exposure thresholds posted on the DOE Chemical Safety Office page at <http://tis.eh.doe.gov/web/chem_safety/teel.html>
Work Smart Standards	The set of work safety standards required to be met in order to perform work safely at LLNL; adopted by the University of California and DOE for inclusion in the contract governing that work.

Appendix B

Facility Screening Report (SCR)

[From UCRL-MA-133867 Document 3.1, "Safety Analysis Program," in the *ES&H Manual*, Appendix B]

<table>
<tr><td colspan="3">LLNL Operation/Building Screening Report
for Initial Hazard Classification</td><td>Building #:</td></tr>
<tr><td colspan="3">Hazard Classification determined to be General Industry:
Yes ❒ No further action required.*
No ❒ Further analysis required (HAR, SAR)**</td><td>Completed by:</td></tr>
<tr><td colspan="3">Probable hazard classification: (Check all that apply)
(1) ❒ (2) ❒ (3) ❒ (R) ❒ Non-Nuclear
(G) ❒ (L) ❒ (M) ❒ (H) ❒ Non-Nuclear
(X) ❒ (A) ❒ Other</td><td>Date:</td></tr>
<tr><td colspan="2">Facility Name:

Facility Contact:</td><td colspan="2"></td></tr>
<tr><td rowspan="2"></td><td colspan="3"></td></tr>
<tr><td>Phone:</td><td colspan="2">L-Code:</td></tr>
<tr><td colspan="4">Operations Conducted at Facility:</td></tr>
</table>

Yes	No	
❒	❒	This project/operation involves only hazards of the type and magnitude associated with activities commonly performed by the public.
❒	❒	ChemTrack inventory is appended (Required if facility has ChemTrack entries.)
❒	❒	ChemTrack inventory contains quantities in excess of 1 lb. of materials with exposure limits or inventory reporting limits (ERPGs, TEELs, RQs, TQs, and TPQs).
❒	❒	Building contains hazardous materials not on the ChemTrack list. (Append list.)
❒	❒	ChemTrack Inventory contains materials that are hazardous in quantities less than 1 lb. (Append list.)

Comments:

* **cc: (1) Building file**

** **Also cc: Facility Contacts and SARA File**

Appendix C

Hazard Analysis Report

Sign-off sheet and Table of Contents

HAZARDS ANALYSIS REPORT

BUILDING XXX

Building Name

Name of DIRECTORATE

Prepared by

Hazards Control Department

Date

Prepared by	_____		
	Name	Safety Analyst	Date
Safety Analysis review by	_____		
	Name	Technical Leader for Safety Analysis	Date
ES&H Team review by	_____		
	Name	ES&H Team Leader	Date
Review by	_____		
	Name	FPOC, Facility Manager or ADFM	Date
Approval by	_____		
	Name	Associate Director (or designee)	Date

University of California
Lawrence Livermore National Laboratory

Table of Contents

Appendix D

Safety Analysis Report

Non-Nuclear Facility

Sign-off sheet and Table of Contents

Facility Name

Safety Analysis Report

Date

Concurred by: *Name*	Approved by: *Name*
(See Section 3.2 for concurrence authority)	**Associate Director, *Facility***

Contents

Chapter 4 Hazard and Safety Analysis

4.1 Hazard Identification

4.2 Inventory
- 4.2.1 Screening results
- 4.2.2 Initial Hazard Classification

4.3 Risk assessment
- 4.3.1 Methodology
- 4.3.2 Review of Potential Accidents
- 4.3.3 Selection of Evaluation Basis Accident

4.4 Summary of safety analysis

Chapter 5 Conduct of Operations

5.1 Purpose

5.2 Controls for Operational Safety
- 5.5.1 Facility Safety Plan
- 5.5.2 Operational Safety Plans

5.3 Safety Structures, Systems, or Components

5.4 Operational Safety Requirements

5.5 ES&H Programs
- 5.5.1 Material Control and Accountability Program
- 5.5.2 Onsite Hazardous Materials Transportation Program
- 5.5.3 Training Program
- 5.5.4 Radiation Protection Program
- 5.5.5 Maintenance Program
- 5.5.6 Emergency Preparedness Program
- 5.5.7 Environmental Protection Program
- 5.5.6 Quality Assurance Program
- 5.5.7 Design and Construction Contractor Organization
- 5.5.8 Human Factors
- 5.5.9 Health Services Program

5.7 Readiness Review

5.8 Facility Operating Records

5.9 Decontamination and decommissioning

Chapter 6 Safety Programs

6.1 Hazards Control Department

6.2 Environmental Protection Department

6.3 Health Services Department

6.4 Business Services Department

Appendices

Tables

Appendix E

Safety Question Review Form

SAFETY QUESTION REVIEW (SQR)

FOR BUILDING XXX

SQR No.: ***BXXX-###—Yr***

Title

Date

_____ This issue does not constitute a Safety Question (all answers are no). The cognizant facility manager approves continued operation.

_____ This issue does constitute a Safety Question (one or more yes answers). The original authorizing office approves continued operation.

Prepared by:

	Name Safety Analyst	Date
Reviewed by	_____	
	Name Safety Analysis Technical Leader	Date
Reviewed by	_____	
	Name ES&H Team ## Leader	Date

Shaded areas optional if there is not a Safety Question

Operation approved by:

Name Facility Manager or Original Authorizing Office	Date

Part I Introduction

This Safety Question Review (SQR) is prepared because:

☐ A change of inventory or operations is proposed above that currently analyzed or bounded by the Safety Basis Envelop (SBE) document.

☐ A potential safety hazard is noted but not identified in the SBE document.

☐ Previous safety analyses were discovered to be inadequate.

☐ See Attachment for details of analysis and supporting documentation.

☐ No attachments.

1. Describe the information being evaluated and the operation that it affects.

2. References used to perform the safety evaluation:

(Add or remove references as appropriate. Remove this instruction from SQR.)

SARA 00-26

LLNL EIS/EIR

FSPs, OSPs *optional*

Existing Safety Analysis

Part II Impact on the Existing Operation

1. List existing controls and equipment that are affected by the new information.

2. Describe how the new information changes understanding of the ways in which the existing controls and equipment might fail.

3. **Identify any previously analyzed or considered accidents that are affected by the changed failure modes.**

4. **Describe how these accidents are affected, such as new means of initiation, changes in probability, or changes in consequence.**

5. **Is the probability of an accident increased by:**

   - Removal of a barrier or barriers committed to in the safety basis document?

   or

   - New information on material(s) or safety SSCs that result in expected probability of an accident moving to a higher probability category. Use probability categories in safety basis document if they exist – otherwise use probability categories in Document 3.1, "Safety Analysis Program," in the *ES&H Manual*, Section 2.1.2.

Part III Potential for a New Accident

1. **Is a new type of accident possible (other than previously analyzed)?**

2. **Provide an analysis of the new accident.** Use the same level of analysis that is in the current safety basis document. If the hazard category of the facility is or could be changed to a higher level by the information, consult your ES&H Team on the appropriate level of analysis.

Part IV Impact on the Margin of Safety (if applicable)

Identify changes to any safety limits that are defined or assumed in the existing safety analysis pertinent changes resulting from the new analysis.

- Does new information indicate that explicitly defined safety limits will require changes? If so, explain.
- Does new information indicated that safety limits invoked by applicable standards could be exceeded? If so explain.
- Does new information indicate that the actual failure of a control in the SAR (e.g. SSC) has been adversely affected?
- If question 3 is answered yes, describe the decrease in the Margin of Safety (i.e. the margin between the safety basis limit and actual failure of the SSC.)
- Identify any new safety limits needed to define margin of in response to the new information

Part V Summary and Conclusions

Summary Questions		Yes	No
Is the likelihood of a safety system malfunction higher than previously expected?	(Part II Item 2)	☐	☐
Is the likelihood or consequences of a previously analyzed accident increased?	(Part II Item 4)	☐	☐
Is there potential for a new type of accident?	(Part III)	☐	☐
Is the margin of safety (if applicable) reduced?	(Part IV Item 2)	☐	☐
Are any new safety limits needed?	(Part IV Item 3)	☐	☐

☐ This issue does not constitute a Safety Question (all answers are no). The cognizant facility manager approves continued operation.

☐ This issue does constitute a Safety Question (one or more yes answers). The original authorizing office approves continued operation.

Appendix F

Unreviewed Safety Issue Form

(For Accelerators only)

UNREVIEWED SAFETY ISSUE (USI)

FOR BUILDING XXX

USI No.: ***BXXX-###—Yr r***

Title

Title of preparing organization, (e.g., Hazards Control Department)

Date

☐ This issue does not constitute a Safety Issue (all answers are no). The cognizant facility manager approves continued operation.

☐ This issue does constitute a Safety issue (one or more yes answers). The original authorizing office approves continued operation.

Prepared by:

	Name e.g., Safety Analyst	Date
Reviewed by	_____	
	Name (e.g., Safety Analysis Technical Leader, Program Leader, Assurance Manager, adding lines as appropriate)	Date
Reviewed by	_____	
	Name ES&H Team ## Leader	Date

Shaded areas optional if there is not a Safety Question

Operation approved by:

Name Facility Manager or Original Authorizing Office	Date

Part I Introduction

This Unreviewed Safety Issue is prepared because:

- ☐ A change of inventory or operations is proposed.
- ☐ A potential safety hazard is noted.
- ☐ Previous safety analyses were discovered to be inadequate.

- ☐ See Attachment for details of analysis and supporting documentation.
- ☐ No attachments.

1. Describe the information being evaluated and the operation that it affects.

2. References used to perform the safety evaluation:

(Add or remove references as appropriate. Remove this instruction from USI.)

SARA 00-26

LLNL EIS/EIR

FSPs, OSPs *optional*

Existing Safety Analysis

Part II Impact on the Existing Operation

1. List existing controls and equipment that are affected by the new information. Identify any of these structures, systems, or components (SSCs) that are essential for protection of the public[§] or workers [**]

[§] **Required to protect the public or prevent adverse environmental effects.**

[**] **Required to prevent acute worker fatality or serious injuries to workers.**

2. Describe how the new information changes understanding of the ways in which the existing controls and equipment might fail.

3. Identify any previously analyzed or considered accidents that are affected by the changed failure modes.

4. Describe how these accidents are affected, including new means of initiation, changes in probability, and changes in consequence.

Part III Potential for a New Accident

1. Is a new type of accident possible?

2. Provide an appropriate analysis of the probability and consequence of the new accident.

Part IV Impact on the safety of operations[††]

1. Identify the safety limits[#] pertinent to the new information that are defined or assumed in the existing authorization basis.

(Examples: Radioactive or chemical inventory thresholds

[††] Safety of operations—separation between safety limits and facility operating limits used in existing safety analysis

[#] Safety limits—inventory safety limits, maximum safe operating parameters, personal protective equipment, maximum exposure limits, barriers, etc.

Working pressure for pressure vessels

Exposure limits for radioactives or chemicals [TEELs]

Respirator specifications)

2. **Describe how closely the existing operating conditions approach these safety limits.**

   (Examples: Ratio of threshold to operating inventory

   Ratio of TEEL 1-hour definition to exposure duration [usually 4x]

3. **Describe the impact of the changed accident scenario on the safety of the operation.**

4. **Identify any new safety limits needed to define the safety of operation in response to the new information.**

   (Examples: New TEEL or inventory limit for new chemical

   New personal protective equipment specifications

5. **Will there be any changes to the accelerator safety envelope (ASE)? What will they be?**

Part V Summary and Conclusions

Summary Questions		**Yes**	**No**
Is the probability of a safety system malfunction higher than previously expected?	(Part II Item 2)	☐	☐
Are the probability or consequences of a previously analyzed accident increased?	(Part II Item 4)	☐	☐
Is there potential for a new type of accident?	(Part III)	☐	☐
Is the safety of operation decreased?	(Part IV Item 3)	☐	☐
Are any new safety limits needed?	(Part IV Item 4)	☐	☐
Are there any changes to the ASEs needed?	(Part IV Item 5)	☐	☐

☐ This issue does not constitute a Safety Issue (all answers are no). The cognizant facility manager approves continued operation.

☐ This issue does constitute a Safety Issue (one or more yes answers). The original authorizing office approves continued operation.

Appendix G

Configuration Management of Facility Hazards and Controls

The overall approach to Configuration Management of Facility-level Hazards and Controls is illustrated in Table G-1. The table lists the various facility hazard categories along with the specific hazard analysis mechanism (e.g., SCR, HAR, SAR, etc.) and references the Facility Authorization Level (FAL). For each type of facility the governing control document (e.g., FSP, SAD, SAR, etc) and the associated change control trigger is shown. For GI, Low chemical and Radiological facilities, the IWS serves as the primary change control trigger. For higher hazard facilities, additional requirements such as Unidentified Safety Issue (USI) for Accelerator facilities, Safety Question Review (SQR) for Moderate and Explosive facilities, and Unresolved Safety Question (USQ) for Category 3 and 2 nuclear facilities are specified.

The configuration management (CM) of the safety basis envelope is graded into four levels. The different facility hazard categories are grouped into the four categories based on the general hazard level. At each level the CM process has four components: Criteria and Systems, Control of Changes, Document Changes and Notification, and Verification. Table G-1 summarizes the CM process for each level and CM component. Table G-2 further expands on this table for each of the hazard categories, and includes the baseline requirement for all facilities. Facility Management is responsible for configuration management of controls and hazards as noted in the table. Table G-3 describes the actions to be taken if it is discovered that conditions in the facility are outside or beyond the Facility Safety Envelop.

Formal delegation of this task may be made to other organizations such as Plant Engineering.

Table G-1. LLNL Facility Hazard Identification, Control and Configuration Management.

Hazard Category	Haz Anal Mechanism	FAL	Control Document	Change Control Trigger	DOE Approval	CM Level	CM Process			
							Criteria & Systems	Control Changes	Doc. Chgs & Notification	Verification
GI	SCR	1	*ES&H Manual*	IWS	N	Level 1	Life Safety systems (facility page, fire alarm, etc.) as defined by NFPA (min), systems identified in SBE document, and inventory limits	PE with FPOC concurrence; Chemtrack and rad inventory by FM	Documented by PE Notified by FM	PE, Facility AD self-assessment
Low	HAR	2	FSP	IWS	N	Level 2	Same as level 1	Same as level 1	FM	AD Self-assessment
RAD	HAR	3	FSP	IWS	N					
Accel	SAD	4	SAD, FSP, ASE	IWS, USI	Y	Level 3	Level 1, SSC's in SAD/SAR, and Administrative controls	Safety basis changes submitted to DOE for approval. Others made through CM program defined in SAD/SAR	FM	AD Self-assessment
Mod	SAR	5	SAR, OSR, FSP	IWS, SQR	Y					
XPL	SAR	6	SAR, OSR FSP	IWS, SQR	Y					
Cat. 3 Nuclear	SAR	7	SAR, TSR, FSP	IWS, USQ	Y					
Cat. 2 Nuclear	SAR	8	SAR, TSR, FSP	IWS, USQ	Y	Level 4	Safety basis changes submitted to DOE for approval. Other changes made through facility specific document for each identified item (systems, hazards &controls) at each level of safety sig.			

Table G-2. Configuration Management of Facility Hazards and Controls.

Note 1: For facilities with multiple ratings (e.g., Accelerator/Low Hazard chemical), configuration management of hazards and controls shall be as identified for both facility classifications as required.

Note 2. For facilities where inventory is above 50% but changes are rare (i.e. less than quarterly or monthly) reconciliation may be done on a transaction basis.

CM Level	Facility Classification	Configuration Management
All	Baseline All Facilities	The ES&H Team can provide facility management with guidance regarding typical GI operations and limits, which are baseline for all facilities. Items for Configuration Management: • Facility Level Controls (FLC)—Life Safety Systems • Facility Level Hazards (FLH)—Inventory Reconciliation against Threshold Limits (Facility Maintained) If typical GI baseline operations and associated baseline supplies are not exceeded, NO further analysis is required by facility management; • Standard Office Activities and materials quality threshold • Standard Machine shop activities and Non-hazards materials thresholds • Janitorial Services • Gardeners
1	General Industry	Items for Configuration Management: • FLC—Controls (e.g. Life Safety Systems) • FLH—Inventory Reconciliation against Threshold Limits • Screening Report (SCR) defines Facility Categorization, facility controls (e.g., systems) for Configuration Management (CM), and materials thresholds for the Facility. Inventories in General Industry are reviewed against SCR thresholds. • Reconcile or manage all inventories annually. In addition (see note 2): — If above 50% of operational threshold (see Appendices I and J), reconcile materials of concern (i.e., major contributors the thresholds) quarterly. — If above 75%, reconcile/manage materials of concern monthly; and manage radionuclide inventory on a transaction basis. • IWS review against SCR for significant change in operations, large quantity shipments of hazardous materials or Work Authorization (WAL) 2 activity or above.

Table G-2. Configuration Management of Facility Hazards and Controls. (cont'd)

CM Level	Facility Classification	Configuration Management

2	Low and Radiological	Items for Configuration Management:
		• FLC—Controls (e.g. Life Safety Systems) and other controls identified in the HAR (facility maintained).
		• FLH—Inventory Reconciliation Threshold Limits defined in the Facility Safety Plan (FSP) (Facility Maintained).
		• Hazard Analysis Report (HAR) defines Facility Categorization, controls for Configuration Management (CM), and materials thresholds for the Facility. Change control is through the IWS process.
		• Reconcile or manage all inventories annually. In addition (see note 2):
		  • If above 50%, reconcile materials of concern quarterly.
		  • If above 75%, reconcile materials of concern monthly. Reconcile radionuclide inventory on a transaction basis.
		• Controls for hazards identified in the HAR are contained in the Facility Safety Plan (FSP).
		• The Integration Work Sheet (IWS) is reviewed against the HAR for significant change in operations, large quantity shipments of hazardous materials or Work Authorization (WAL) 2 activity or above

3	Accelerator	Items for Configuration Management: • FLC—Life Safety Systems (Plant Engineering maintained) and other controls identified in the SAD (facility maintained). • FLC—Controls (e.g., Safety Systems, Structures, and Components) identified in Safety Assessment Document (SAD). • Safety Assessment Document (SAD) defines Facility Categorization, controls for Configuration Management (CM). Change control is through the Unreviewed Safety Issue (USI) process. • Controls for hazards identified in the SAD and Accelerator Safety Envelop (ASE) are contained in the Facility Safety Plan (FSP), Operational Safety Plan (OSP). • IWS review against SAD required for significant change in operations, large quantity shipments of hazardous materials or Work Authorization (WAL) 2 activity or above.

Table G-2 Configuration Management of Facility Hazards and Controls. (cont'd)

CM Level	Facility Classification	Configuration Management
3	Moderate	Items for Configuration Management: • FLC—Life Safety Systems and other controls identified in the SAR (facility maintained). • FLH—Inventory Management within SAR Limits (Facility Maintained). • FLC—Controls (e.g., Safety Systems, Structures, and Components) identified in Safety Analysis Report (SAR) • Safety Analysis Report (SAR) defines Facility Categorization, controls for Configuration Management (CM). Change control is through Safety Question Review (SQR) process. • Controls for hazards identified in the SAR and Operational Safety Requirements (OSRs) are contained in the Facility Safety Plan (FSP). • The IWS is reviewed against the SAR for significant change in operations, large quantity shipments of hazardous materials or Work Authorization (WAL) 2 activity or above.
3	Explosives Facility	Items for Configuration Management: • FLC—Life Safety Systems (Plant Engineering maintained) and other controls identified in the SAR (facility maintained). • FLH—Inventory Management within SAR Limits (Facility Maintained). • FLC—Controls (e.g., Safety Systems, Structures and Components) identified in Safety Assessment Report (SAR) • Safety Analysis Report (SAR) defines Facility Categorization, systems for Configuration Management (CM). Change control is through Safety Question Review (SQR) process. • Controls for hazards identified in the SAR and Operational Safety Requirements (OSRs) are contained in the Facility Safety Plan (FSP). • The IWS is reviewed against the SAR for significant change in operations, large quantity shipments of hazardous materials or Work Authorization (WAL) 2 activity or above.

Table G-2 Configuration Management of Facility Hazards and Controls. (cont'd)

CM Level	Facility Classification	Configuration Management
3	Category 3 Nuclear Facility	Items for Configuration Management: • FLC—Life Safety Systems (Plant Engineering maintained) and other controls identified in the SAR (facility maintained). • FLH—Inventory Management within SAR Limits (Facility Maintained) • FLC—Controls (e.g., Safety Systems, Structures and Components) identified in Safety Assessment Report (SAR). • Safety Analysis Report (SAR) defines Facility Categorization, identifies systems for Configuration Management (CM). Change control is through the Unreviewed Safety Question (USQ) process. • Controls for hazards identified in the SAR and TSRs are contained in the Facility Safety Plan (FSP). • The IWS is reviewed against the SAR for significant change in operations, large quantity shipments of hazardous materials or Work Authorization (WAL) 2 activity or above.
4	Category 2 Nuclear Facility	Items for Configuration Management: • FLC—Life Safety Systems (Plant Engineering maintained) and other controls identified in the SAR (facility maintained). • FLH—Inventory Management within SAR Limits (Facility Maintained). • FLC—Controls (e.g., Safety Systems, Structures and Components) identified in Safety Assessment Report (SAR) • Safety Analysis Report (SAR) defines Facility Categorization, identifies systems for Configuration Management (CM). Change control is through the Unreviewed Safety Question (USQ) process. • Controls for hazards identified in the SAR and TSRs are contained in the Facility Safety Plan (FSP). • The IWS is reviewed against the SAR for significant change in operations, large quantity shipments of hazardous materials or Work Authorization (WAL) 2 activity or above.

Table G-3 Discovery of operations beyond the Facility Safety Basis Envelop

I. For General Industry Facilities:

A. If the operational threshold limit on hazardous materials for a General Industry (GI) Facility is exceeded into Low or Radiological Category quantities the following steps need to be taken:

1. The appropriate Facility Management shall verify an overage exists in a timely manner
2. Applicable operations shall be evaluated immediately and stood down in a controlled and safe manner. The ES&H Team shall provide assistance in identifying safe stand down considerations
3. Facility Management shall notify the ES&H Team Leader, and the cognizant Assurance Manager who will assist or determine reportability.
4. Compensatory measures (i.e., controls) shall be developed, if necessary, by Facility Management with the assistance of the ES&H Team, as necessary, to reduce risk to acceptable level.
5. Written authorization shall be obtained from the Facility Associate Director, with prior written concurrence from the ES&H Team Leader, to continue to operate with the compensatory measures.
6. The problem is corrected by either reducing inventory to authorized levels or completing a Hazard Analysis Report (HAR) and implementing appropriate long-term controls.

B. If the threshold inventory of explosives for a GI Facility is exceeded into Explosive Facility categorization the following steps need to be taken:

1. The Facility Management shall verify an overage exists in a timely manner.
2. Applicable operations shall be stood down in a controlled and safe manner. The ES&H Team shall provide assistance in identifying safe stand down considerations.
3. Facility Management shall notify 1) the ES&H Team Leader 2) the Institution (during transition this is the Hazards Control Department Head), and the cognizant Assurance Manager who will determine reportability.

If the inventory cannot be reduced below the threshold, or there is a desire to operate at the higher level, do the following:

4. Complete appropriate change review document; Safety Question Review (SQR).

5. Compensatory measures (i.e., controls) shall be developed by the Facility Management with the assistance of the ES&H Team, as necessary, to reduce risk to acceptable level.
6. Obtain approval from DOE/OAK, with prior written concurrence from the Facility AD and the Deputy Director for Operations (DDO), to continue to operate with the compensatory measures.
7. Correct problem by either reducing inventory to authorized levels or completing a safety analysis and implementing appropriate long-term controls.

II. For Low Hazard or Radiological Facilities:

If Low or Radiological Facilities exceed thresholds into Moderate Hazard or Category 3 Nuclear respectively the following steps need to be taken:

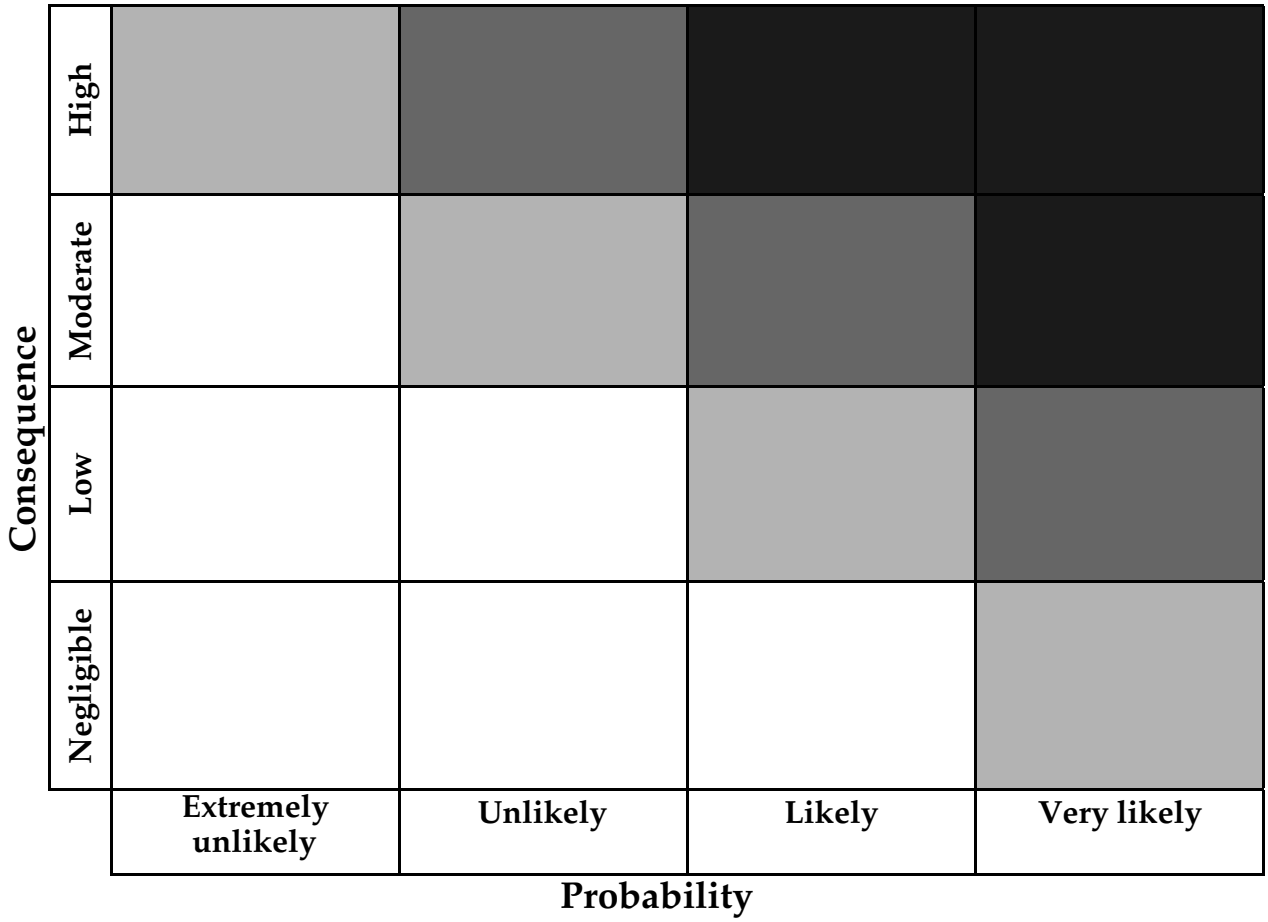
1. The Facility Management shall verify an overage exists in a timely manner.
2. Applicable operations shall be stood down in a controlled and safe manner. The ES&H Team shall provide assistance in identifying safe stand down considerations
3. Facility Management shall notify 1) the ES&H Team Leader 2) the Institution (during transition this is the Hazards Control Department Head), 3) the cognizant Assurance Manager for determination of reportability, and 4) the PAAA Office if Radiological/Cat 3 threshold is exceeded.

If the inventory cannot be reduced below the threshold, or there is a desire to operate at the higher level, do the following:

4. Complete appropriate change review document; for Moderate Hazard a Safety Question Review (SQR), for Category 3 Nuclear an Unresolved Safety Question (USQ).
5. Compensatory measures (i.e., controls) shall be developed by the Facility Management with the assistance of the ES&H Team, as necessary, to reduce risk to acceptable level.
6. Obtain approval from DOE/OAK, with prior written concurrence from the Facility AD and the Deputy Director for Operations (DDO), to continue to operate with the compensatory measures.
7. Correct problem by either reducing inventory to authorized levels or completing a safety analysis and implementing appropriate long-term controls.

Appendix H

LLNL Risk Matrix



Risk Acceptance at LLNL

	High	**Unacceptable**
	Medium	**Acceptable with DDO concurrence**
	Low	**Acceptable**
	Negligible	**Acceptable**

Appendix I

Building Hazard Classification Criteria

Summary and Copies of Adopted Quantity Thresholds

Initial screening of buildings to determine their "hazard classification" is based on comparison of the quantities of specified materials in a building or part of a building to the tables enclosed below. In the case of hazardous chemical, the screening is performed against the quantity of each individual chemical type. For facilities with chemicals that are not on the lists and that cannot be removed from consideration by the criteria listed in Section 2.7.1, no initial classification is possible. For radioactive materials, the screening is based on comparison of the cumulative fraction of each material compared its criteria value. For explosives, initial screening of a facility with any explosives will determine if it is an explosives facility. Finally, for accelerator facilities, if the accelerator is capable of producing particles with an energy level of 10 MeV or above and capable of producing a radiological area potentially exposing the whole body of a receptor, it is initially classified as an accelerator facility. Further documentation, looking at the effect of unusual hazards, chemicals not on the lists provided or the results of more in depth analysis may cause the initial hazard classification of the facility to be altered. The applicable tables for initial differentiation between the different categories are attached.

After initial screening establishes the hazard rank (FAL) of the facility and its safety basis envelop, the FM, FPOC, or other interested people may use the tables as a tool to maintain the SBE or to ensure that the SBE is not violated. Starting with Figure 2, look in the box for the applicable facility, and identify the appropriate table to evaluate a particular chemical or radioactive material. Find the material in the table, and see if the proposed new quantity, in addition to the existing quantity in the facility, exceeds the stated limit. Note that the SAR or HAR for some facilities may set the SBE to quantities lower than those listed in the tables. The SBE can be maintained by reducing inventory, withholding concurrence for a new or revised activity, or obtaining a management decision to have the facility classified at a higher level.

Index of Lists

<table>
<tr><th>CHEMICAL CLASSIFICATIONS</th><th>RADIOACTIVE MATERIALS CLASSIFICATIONS</th><th>EXPLOSIVE CLASSIFICATION</th><th>ACCELERATOR CLASSIFICATION</th></tr>
<tr><td></td><td><u>Nuclear 1 Category</u>
DOE assigned, not generally used</td><td rowspan="4"><u>Explosives Facility</u>
• Classified as an explosive handling facility if any amount of explosive is used unless a HAR determines that only the handler is at risk
• SAR or HAR, FSP and OSP, IWS required
• DOE approves SAR
• Process Safety Management applies (29 CFR 1910.119) in some cases</td><td rowspan="4"><u>Accelerator Facility</u>
• Classified as accelerator facility if more than 10 MeV is produced and,
• Capable of producing a radiological area potentially exposing the whole body of a receptor
• SAD, FSP, OSP, IWS Required
• DOE Approves SAD and conducts a readiness review before accelerator startup</td></tr>
<tr><td><u>High Hazard Category</u>
• Not Used</td><td><u>Nuclear 2 Category</u>
• Below cumulative radionuclide ratios in columns 2&3 in DOE S 1027, Attachment 1, table A.1
• SAR, FSP, OSPs required
• DOE approves SAR</td></tr>
<tr><td><u>Moderate Hazard Category</u>
Above:
• Threshold Quantity (TQ) in 29 CFR 1910.119, Appendix A
• Threshold Planning Quantity (final column,) in 40 CFR 355, Appendix A
• SAR, FSP, OSPs, IWSs required
• DOE approves SAR</td><td><u>Nuclear 3 Category</u>
• Below cumulative radionuclide quantity ratios for Nuclear Category 2, but above cumulative quantity ratio in Columns 4&5 in DOE S 1027, Attachment 1, table A.1
• SAR, FSP, OSPs, IWSs required
• DOE Approves SAR</td></tr>
<tr><td><u>Low Hazard Category</u>
Below criteria for Moderate Hazard, but above criteria in:
• 40 CFR 355, Appendix A (Middle Column, Reportable Quantities)
• 40 CFR 302.4, Appendix A Final reportable quantities (RQ) in last column
• HAR, FSP, OSP, IWS
• LLNL Approved</td><td><u>Radiological Category</u>
Below criteria for Nuclear category 3 facility, but above reportable quantities in :
• 40 CFR 302.4 Appendix B. Final Reportable Quantities (RQ), last column
• HAR, FSP, OSP, IWS
• LLNL Approved</td></tr>
<tr><td colspan="4"><u>General Industry Classification</u>:
Below Reportable Quantities (Chemicals) in 40 CFR 355, Appendix A,(middle column)
Below Final Reportable Quantities [RQ](Chemicals) in 40 CFR 302.4, last column
Below the Radiological Threshold (Radioactive Chemicals) Listed in 40 CFR 302.4, Appendix B (Final RQ)
No unusual chemicals not on lists above
No non-routine hazards
Safety Analysis Documentation: Facility Screening Report (LLNL Approval Only)
Other Documentation Which May Be Needed: IWSs, OSPs</td></tr>
</table>

Figure 2. Facility Hazard Classification Thresholds

Terms:

SAD- Safety Assessment Document
HAR-Hazards Analysis Report
FSP- Facility Safety Plan
IWS- Integration Work Sheet
SAR- Safety Analysis Report
SCR- Facility Screening Report
OSP- Operational Safety Plan